FLOWERS AND INSECTS. XVII.

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For a more extended title of this series I have adopted that of "Contributions to an account of the ecological relations of the entomophilous flora and the anthophilous insect fauna of the neighborhood of Carlinville, Illinois." The following papers should be regarded as parts of the same series: Flowers and Insects: Umbelliferæ. *Trans. St. Louis Acad. Science* **5:** 449–460. 1890; Asclepiadaceæ to Scrophulariaceæ, *ibid.* **5:** 569–598. 1891; Labiatæ. *ibid.* **6:** 101–131. 1892. (no. 4); Rosaceæ and Compositæ, *ibid.* **6:** 435–480. 1894. (no. 14); Flowers and Insects, *ibid.* **7:** 151–179. 1896. (no. 6); The Philosophy of Flower Seasons, American Naturalist **29:** 97–117. 1895. The cases of some plants, such as those observed in Florida, which properly do not come under the title, are distinctly specified.

The present paper discusses a number of plants, which, although not akin, should be compared because of the influence which their greenish yellow colors have been considered to have in determining the character of the insect visits.

CAULOPHYLLUM THALICTROIDES (L.) Michx. is a perennial plant, rather frequent in rich woods, and blooming a short time, April 23d to May 7th. The stems grow several decimeters high and bear single small loose panicles of yellowish green flowers. The flowers expand horizontally about 10^{mm}, and, I think, remain open at night. Each of the six sepals has, lying upon its base, a short petal which is somewhat kidney-shaped, being expanded into a nectar gland as wide as the sepal. The style is very short and is tipped by a small stigma, which is receptive before the anthers dehisce. From the shortness of the stamens, as well as their later dehiscence, I think that spontaneous self-pollination does not occur. According to the views usually held with regard to

flowers of like color and nectar exposure, we might expect a strong predominance of flies. My observations do not show this.

With the exception of no. 18, taken April 23d, the following list was observed on May 1st:

HYMENOPTERA—*Andrenidæ*: (1) Halictus confusus Sm. ♀, s. & c. p.; (2) H. 4-maculatus Rob. ♀, s.; (3) Augochlora viridula Sm. ♀, s.; *Braconidæ*: (4) Bracon trifolii Ashm.; (5) B. veronniæ Ashm.; (6) Microgaster gelechiæ Riley, ab.; (7) Opius ruficeps Prov.; (8) Dacnusa flavicincta Ashm.; *Chalcididæ*: (9) Prosacantha illinoensis Ashm. (MS)—all s.

DIPTERA—*Mycetophilidæ*: (10) Dynatosoma thoracica Coq. (MS); *Empidæ*: (11) Rhamphomyia piligeronis Coq. (MS); *Syrphidæ*: (12) Chilosia capillata Lw.; (13) Melanostoma obscurum Say; (14) Rhingia nasica Say; *Anthomyidæ*: (15) Hylemyia plumosa Coq. (MS); (16) Mydæa flavipes Coq. (MS); *Oscinidæ*: (17) Chlorops trivialis Lw.— all s.

COLEOPTERA—*Mordellidæ*: (18) Mordellistena biplagiata Hel.; *Curculionidæ*: (19) Idiostethus subcalvus Casey, both s.

PTELEA TRIFOLIATA L.—According to Hildebrand (1) and Kerner (3), the flowers are staminate and perfect. Urban (2) indicates that *Ptelea* is dicœcious, and that self-pollination is impossible. As far as I have observed, it has appeared that this species is dicœcious. I could find no perfect flowers.

The greenish white blossoms expand from 10 to 15^{mm} and are crowded in compound cymes, which are nearly level topped and form convenient resting places for insects. In both forms nectar is secreted by the gynophore and is slightly concealed by the hairy bases of the filaments.

The following table shows the kinds of insects taken on *Xanthoxylum Americanum* and *Ptelea trifoliata*, the former blooming from April 12th to 28th and the latter from May 8th to June 12th:

	Other Hymenoptera	Apidæ	Andrenidæ	Diptera	Lepidoptera
Xanthoxylum Americanum (39)	0	6	19	13	1
Ptelea trifoliata (51)	12	1	22	14	2

The difference in Apidæ may be partly on account of the former having the nectar more concealed, but is mainly, I think, on account of the blooming time. At any rate, three of the Apidæ taken on *Xanthoxylum* have finished their flight before

Ptelea goes out of bloom. Of the twelve species of lower Hymenoptera taken on *Ptelea*, not one is flying during the period of *Xanthoxylum*. The inflorescence of *Ptelea* is more favorable for their visits.

The principal pollinators are Andrenidæ. May 28th, 30th and June 1st, 4th and 8th the following list was observed:

HYMENOPTERA—*Apidæ*: (1) Apis mellifica L. ☿, s., freq.; *Andrenidæ*: (2) Halictus coriaceus Sm. ♀, s.; (3) H. ligatus Say ♀, s.; (4) H. lerouxii Lep. ♀, s.; (5) H. cressonii Rob. ♀, s. & c. p.; (6) H. pilosus Sm. ♀, s.; (7) H. confusus Sm. ♀, s. & c. p.; (8) H. stultus Cr. ♀, s. & c. p.; (9) H. tegularis Rob. ♀, s. & c. p.; (10) Agapostemon radiatus Say, ♀, s.; (11) Augochlora pura Say, ♀ s.; (12) Andrena roberteonii D. T., ♀, s. & c. p., freq.; (13) A. platyparia Rob. ♂♀, s. & c. p.; (14) A. cressonii Rob. ♀, s.; (15) A. bipunctata Cr. ♀, s. & c. p., freq.; (16) A. nuda Rob. ♀, s. & c. p.; (17) A. rugosa Rob. ♀, s.; (18) A. spiræana Rob. ♂♀, s.; (19) A. hippotes Rob. ♀, s. & c. p., ab.; (20) A. claytoniæ Rob. ♀, s., freq.; (21) A. cratægi Rob. ♀, s. & c. p.; (22) Sphecodes confertus Say ♀, s., freq.; (23) Prosopis modesta Say, ♂, s.; *Eumenidæ*: (24) Eumenes fraternus Say, s.; (25–27) Odynerus spp., s.; (28) O. unifasciatus Sauss., s.; (29) O. tigris Sauss., s.; (30) O. foraminatus Sauss., s.; *Crabronidæ*: (31) Oxybelus illinoensis Rob. (MS), s.; *Philanthidæ*: (32) Cerceris compar Cr., s.; *Sphecidæ*: (33) Ammophila vulgaris Cr., s.; *Scoliidæ*: (34) Elis confluenta Say, s.; *Chalcididæ*: (35) Leucospis affinis Say, s.

DIPTERA—*Stratiomyidæ*: (36) Stratiomyia meigenii Wd.; *Conopidæ*: (37) Conops brachyrhynchus Mcq., s.; (38) Myopa vesiculosa Say, s.; *Syrphidæ*: (39) Sphærophoria cylindrica Say, s.; (40) Myolepta nigra Will., s.; (41) Volucella vesiculosa F., s.; (42) Mallota cimbiciformis Fil. f. bautias Wlk., s.; (43) Syritta pipiens L., s.; *Tachinidæ*: (44) Trichopoda sp., s.; (45) Jurinia smaragdina Mcq., s.; (46) J. apicifera Wlk., s.; (47) Micropalpus fulgens Mg., s.; *Muscidæ*: (48) Lucilia cornicina F., s.; *Anthomyidæ*: (49) Phorbia fusciceps Zett.

LEPIDOPTERA—*Rhopalocera*: (50) Neonympyha eurytris F., s.; *Heterocera*: (51) Alypia octomaculata Hbn.

Trelease (MS notes) captured the following insects on the flowers:

HYMENOPTERA—*Apidæ*: (1) Psithyrus (Apathus) laboriosus F., ♀; (2) Nomada sp.; *Andrenidæ*: (3) Halictus pilosus Sm., ♀; (4) Andrena pruni Rob., ♀; (5) A. illinoensis Rob., ♀; (6) A. cratægi Rob., ♀; (7) Agapostemon viridulus F., ♀; (8) Sphecodes confertus Say, ♀; (9) Prosopis modesta Say, ♀; *Vespidæ*: (10) Vespa germanica F.; (11) Polistes metricus Say; *Eumen-*

idæ: (12) Odynerus albophaleratus Sauss.; *Crabronidæ*: (13) Oxybelus 4-notatus Say; *Philanthidæ*: (14) Cerceris pedalis Cr.

COLEOPTERA—*Coccinellidæ*: (15) Analia bipunctata L.; *Dermestidæ*: (16) Anthrenus scrophulariæ L.; *Lampyridæ*: (17) Chauliognathus pennsylvanicus De G.; and other insects which I have not seen, probably flies.

On the literature of *Ptelea* see:

(1) Hildebrand, Geschlechtsvertheilung bei den Pflanzen, **11**:26. 1867. —(2) Urban, Zur Biologie und Morphologie der Rutaceen, Jahrb. bot. Gartens Berlin **2**:397–8. 1883. (Just **11**[1]:497.)—(3) Kerner, Pflanzenleben **2**:295. 1891. (Just **18**[1]:486.)

RHAMNUS L.—The species which have been studied are diœcious—*R. cathartica* (Darwin 7), *saxatilis* and *tinctoria* (Kerner 19)—or with flowers perfect, as in *R. Frangula* and *pumila* (Müller 3, 11), the former being proterandrous and the latter homogamous. *R. cathartica* has four sub-forms (Darwin 7), and *Frangula* shows a tendency to produce a long and short-styled form, as in our *R. lanceolata* (Schulz 17).

The flowers are small, greenish, with easily accessible nectar and have been considered to be adapted to flies (Delpino 5, Müller 12, 13), but this does not seem to be supported by sufficient data. Still more extreme is the limitation of the proper visitors to flesh-flies (Kerner 19). My list of visitors of *R. lanceolata* resembles those of white or yellow flowers with similarly placed nectar and blooming about the same time. The results of the observation of different species in separate regions is given in the following table:

	Apidæ	Andrenidæ	Other Hymenop	Diptera	Coleoptera	Total
Rhamnus lanceolata, Illinois	4	23	3	22		52
R. Frangula, Low Germany, Müller (3, 10)	2	1	2	1		6
R. Frangula, Flanders, MacLeod (20)	2			1	1	4
R. pumila, Alps, Müller (11)			4	8	5	17

RHAMNUS LANCEOLATA Pursh.—According to Darwin (7), this species is dimorphous, but not properly heterostyled. The small trees grow as high as three or four meters and bear

numerous greenish flowers which appear with the leaves. The stamens are exserted so that the pollen may be eaten by Syrphidæ or collected by Andrenidæ, but the style is short and included. The calyx tube is about 2^{mm} deep and 1^{mm} wide. Consequently the nectar, which is secreted by a disk lining the tube, is readily accessible to small, short-tongued insects. From their structure and blooming time, April 23d to May 10th, the flowers seem to be specially adapted to Andrenidæ, but they are also visited less abundantly and less efficiently by flies. On the 1st and 2d of May I captured the following visitors:

HYMENOPTERA—*Apidæ:* (1) Apis mellifica L. ☿, s., one; (2) Bombus americanorum F. ♀, s.; (3) Ceratina dupla Say ♂, s.; (4) Nomada maculata Cr. ♀, s.; *Andrenidæ:* (5) Halictus foxii Rob. ♀, s. and c. p., freq.; (6) H. arcuatus Rob. ♀, s. and c. p.; (7) H. forbesii Rob. ♀, s. and c. p.; (8) H. lerouxii Lep. ♀, s. and c. p.; (9) H. fasciatus Nyl. ♀, s. and c. p., ab.; (10) H. pilosus Sm. ♀, s. and c. p., freq.; (11) H. confusus Sm., ♀, s. and c. p., freq.; (12) H. pruinosus Rob. ♀, s.; (13) H. illinoensis Rob. ♀, s.; (14) H. zephyrus Sm. ♀, s. and c p.; (15) H. stultus Cr. ♀; (16) Agapostemon radiatus Say ♀, s., freq.; (17) Augochlora viridula Sm. ♀, s.; (18) A. pura Say ♀, s. and c. p., freq.; (19) A. labrosa Say ♀, s. and c. p.; (20) Andrena erythrogastra Ashm. ♂, s.; (21) A. mandibularis Rob. ♀, s.; (22) A. nasonii Rob. ♀, s. and c. p.; (23) A. cressonii Rob. ♂♀, s. and c. p., ab.; (24) A. bipunctata Cr ♂, s.; (25) A. ziziæ Rob. ♂♀, s. and c, p., freq.; (26) A. cratægi Rob. ♂, s.; (27) Sphecodes mandibularis Cr. ♀, s.; *Eumenidæ:* (28) Eumenes fraternus Say, s.; (29) Odynerus tigris Sauss., s.; *Tenthredinidæ:* (30) Dolerus arvensis Say, s.

DIPTERA—*Empidæ:* (31) Rhamphomyia priapulus Lw.; *Syrphidæ:* (32) Pipiza femoralis Lw.; (33) Chrysogaster nitida Wd.; (34) Syrphus ribesii L.; (35) S. americanus Wd.; (36) Xanthogramma felix O. S.; (37) Allograpta obliqua Say, freq.; (38) Mesograpta geminata Say, ab.; (39) M. marginata Say; (40) Sphærophoria cylindrica Say, freq.; (41) Helophilus similis Mcq.; (42) Syritta pipiens L.; *Tachinidæ:* (43) Cyphocera fuesta V. d. W.; *Sarcophagidæ:* (44) Cynomyia mortuorum L.; (45) Sarcophaga ægra Wlk.; (46) S. cimbicis Twns.; *Muscidæ:* (47–48) Lucilia spp.; (49) L. latifrons. Schin.; *Cordyluridæ:* (50) Scatophaga squalida Mg.; *Anthomyidæ:* (51) Phorbia acra Wlk.; (52) P. fusciceps Zett.—all s. or f. p.

On the literature of *Rhamnus* see:

(1) Darwin, on the two forms, or dimorphic condition, in the species of *Primula*, and on their remarkable sexual relations; Journ. Linn. Soc. Bot. 6:95. 1862—*R. lanceolata.* (2) Hildebrand, Geschlechtsvertheilung bei den Pflanzen 9:40. 1867—*R. cathartica, lanceolata.* (3) Müller, Befruchtung

der Blumen 152. 1873—*R. Frangula.* (4) Kerner, Die Schutzmittel des Pollens 56. 1873. (5) Delpino, Ulteriori osservazioni, pt. II, fasc. 2:20, 214, 300, 316, Att. Soc. Ital. Sci. Nat., Milano **16**:168. 1873; **17**:——. 1874 —*R. cathartica, Frangula, alterna* (Just **2**:895). (6) Lubbock, British wild flowers in relation to insects 79. 1875—*R. cathartica, Frangula, lanceolata.* (7) Darwin, Forms of flowers, 273–7. 1877—*R. cathartica, lanceolata, Frangula.* (8) Bonnier, Les Nectaires, Ann. Sci. Nat. Bot. **8**:39. 1878. *R. Frangula, alpina,* inconspicuous flowers abundantly visited. (9) Dodel-Port, Die Liebe der Blumen **4–5**:185–240. 1880—*R. cathartica* (Just **8**[1]:183). (10) Müller, Weitere Beobachtungen, II, Verh. naturhist. Ver. preuss. Rheinl. u. Westf. 212. 1879—*R. Frangula.* (11) Müller, Alpenblumen 169–71. 1881—*R. pumila.* (12) Müller, Geschichte der Erklärungsversuche in Bezug auf die biologische Bedeutung der Blumenfarben, Kosmos **12**:125, N., 1882 (Just **9**[1]:506). (13) Müller, Die biologische Bedeutung der Blumenfarben, Biol. Centralblatt **3**:99, Ap. 1883. (14) Müller, Die Stellung der Honigbiene in der Blumenwelt, III, Deutsche Bienenzeit. **39**:157–61. 1883—*R. pumila,* Apis wanting. (15) Müller, Fertilization of flowers, 163–4. 1883—*R. Frangula, cathartica, lanceolata, pumila.* (16) Kirchner, Flora von Stuttgart und Umgebung, 363–4. 1888—*R. Frangula, cathartica.* (17) Schulz, Beiträge zur Kenntniss der Bestäubungseinrichtungen und Geschlechtsvertheilung bei den Pflanzen, **1**:31. 1888; **2**:61, 185. 1890. Bibliotheca Botanica, 10 und 17—*R. Frangula, cathartica, pumila.* (18) Trelease, North American Rhamnaceæ, Trans., St. Louis Acad. Sci. **5**:359. (19) Kerner, Pflanzenleben, **2**:169, etc. 1891—*R. cathartica, saxatilis, tinctoria.* (20) MacLeod, Over de bevruchting der bloemen in het kempisch gedeelte van Vlaandern, Bot. Jaarbock. **6**:247–9, 438, 1894—*R. Frangula, cathartica.* (21) Loew, Blütenbiologische Floristik **36**:215. 1894—*R. pumila, Frangula, cathartica, saxatilis.*

Rhus L.—The species are said to be polygamous or polygamo-dïœcious. It might be better to call them diœcious, though of a recent form, for the staminate and pistillate flowers have large rudiments of pistils and stamens, and there is a tendency for them to revert to the perfect condition. Müller (4, 14) and Kerner (16) mention *R. Cotinus* as polygamous; but in Halle and in South Tyrol Schulz (15) found it to be diœcious, though it appears (Loew[1] 20) that in the former locality he afterwards found polygamous examples. In the manual *R. typhina* is called polygamous, while Müller calls it diœcious.

[1] In the Floristik, unfortunately, Loew mentions an author without citing any of the separate papers listed under that author's name.

Meehan (6, 18) referring to the fact that *R. copallina*, *venenata* and *Toxicodendron* are variously classed as dicœcious, polygamo-dicœcious, or polygamous, insists that they and *R. cotinoides* are all truly dicœcious. I regard *R. glabra* and *Canadensis* as dicœcious.

In regard to the staminate, perfect, and pistillate flowers of *R. Cotinus*, Müller observes that they decrease in size in the order mentioned, and that, consequently, most insects visit them in the most advantageous order. Schulz failed to confirm the latter observation. In *R. glabra* and *Canadensis*, I think insects prefer the staminate flowers, partly because they are more conspicuous and because they contain pollen as well as nectar, and that the order of their visits is advantageous. However, I do not believe that natural selection has operated in producing the difference, and so hold that it would be erroneous to say that the difference exists to secure the advantage. As a rule stamens are more conspicuous than pistils, and it is quite obvious that a small flower containing five stamens will be more evident than one containing a single pistil. The larger perianth may be explained as existing to support, and at first to protect, this exterior set of organs.

Two effects upon the insect visitors have been attributed to the dull yellow colors of *Rhus*. Müller says that *R. Cotinus*, like all other flowers of a dull yellow color, is almost completely avoided by Coleoptera. The general proposition is denied by Bonnier (9), and Schultz says that it is not true for *R. Cotinus* in the Tyrol, where he found many beetles among the visitors. *Pastinaca*, on which I have taken forty species of beetles, is mentioned by Müller as an example of the same kind.

The idea that the flowers of *Rhus* were specially attractive to flies (macromyiophilous) seems to have originated with Delpino (5). The "Tipo ramnaceo," which he regards as macromyiophilous, includes the greenish yellow species of *Rhus*, *Rhamnus*, *Euonymus*, *Euphorbia*, etc. In a special paper on the biological significance of flower-colors Müller (12) says that greenish yellow colors are frequent in flowers among whose visitors the

larger Diptera predominate. Both authors distinguish these cases from the dark colored flowers, like *Stapelia*, *Asimina*, etc., which they consider to be adapted to flesh flies. The view in regard to the greenish yellow flowers does not seem to have been supported, if not entirely refuted, by subsequent investigations. Kerner's view (16) that these colors are specially attractive to flesh flies was never held either by Delpino or Müller, and so may be considered to be supported neither by authority nor recorded observations. Of the greenish yellow flowers which bloom in my neighborhood I have found a preponderance of general Diptera on none except *Sassafras*. Indeed I expect *Smilax herbacea* and *S. ecirrhata* to show a preponderance of flesh flies, but they differ from the others, and from all of the cases cited by Kerner, in having a scent of carrion.

The following table gives results of observations of insect visitors of *Rhus* in cases in which the species have been identified. The Andrenidae and lower Hymenoptera preponderate over the Diptera. In the Tyrol Schulz saw *R. Cotinus* very abundantly visited by a set of insects which in a general way must resemble my list for *R. glabra* (19).

	Apidæ	Andrenidæ	Other Hymenop	Dipteria	Other insects	Total
Rhus Cotinus — Low Germany — Müller (4,14)	1	3	6	6	1	17
Rhus typhina — Low Germany — Müller (4,14)	1	1	..	..	1	3
Rhus glabra—Illinois (19)	3	16	13	25	1	58
Rhus Canadensis — Illinois (19)	2	21	1	9	..	33

Rhus Canadensis Marsh. *R. aromatica* Ait. This is a slender shrub growing on high creek banks, the stems rising from 1 to 2^{m} high. The branchlets are terminated by clusters of about three small, head-like racemes, which measure $8–10^{mm}$ in length, and appear before the leaves. The flower buds escape from hibernacula whose scales still clasp the bases of the stalks.

The flowers are small, greenish yellow, with short petals. They are quite shallow, the nectar being almost freely exposed. Nectar is secreted by five orange colored glands situated between the bases of the filaments. The staminate flowers have the petals a little longer and more often expanded, so that this form is the more conspicuous. The nectar glands are larger, more triangular and united at base. The pistil is so strongly developed that the flower appears to be perfect. In the pistillate flower the nectar glands are more bilobed. The stamens are of normal form, but greatly reduced in size, and are without pollen. Both forms are abundantly visited by insects.

In the case of *Xanthoxylum Americanum*, which blooms from April 12th to 28th, and *Ptelea trifoliata*, blooming from May 8th to June 12th, we have observed that the lists differ in the absence of the lower Aculeata from *Xanthoxylum*. This was explained as a result of the difference in their blooming time. If we compare *R. Canadensis*—April 4th to 27th—with *R. glabra*—June 8th to 24th—we find the same result. In the former case not one of the lower Aculeata occurring on *Ptelea* flies while *Xanthoxylum* is in bloom. Here we have a similar condition, for *Polistes metricus* is the only one taken on *R. glabra* which is flying during the flower season of *R. Canadensis*. The large inflorescences of *Ptelea* and *R. glabra* form more convenient resting places for these often large straddling insects. The differences in the inflorescences may be accounted for partly by the difference in the composition of the late insect fauna; but the early months, when there is apt to be frost, are not favorable for the development of large flower clusters. Then, too, before the leaves appear, the smaller clusters are sufficiently conspicuous. Other differences in the lists are connected with the blooming time, viz., the advent of *Prosopis*, substitution of two late *Colletes* for the early *C. inaequalis*, and an increase of *Halictus* associated with the decline of the vernal species of *Andrena*.

The following visitors of *R. Canadensis* were taken on April 4th, 10th, 12th and 19th:

HYMENOPTERA—*Apidæ*: (1) Ceratina tejonensis Cr., ♂; (2) Nomada

maculata Cr., ♂♀, freq.; *Andrenidæ*: (3) Halictus sp. ♀; (4) H. foxii Rob., ♀, freq.; (5) H. forbesii Rob., ♀, freq.; (6) H. ligatus Say, ♀; (7) H. cressonii Rob., ♀; (8) H. zephyrus Sm., ♀, freq.; (9) H. stultus Cr., ♀; (10) Agapostemon texanus Cr., ♀; (11) Augochlora pura Say, ♀; (12) Andrena sp. ♂♀, freq.; (13) A. vicina Sm., ♂♀, freq.; (14) A. erythrogastra Ashm., ♀; (15) A. mandibularis Rob., ♂♀, freq.; (16) A. illinoensis Rob., ♀; (17) A. cressonii Rob., ♂; (18) A. bipunctata Cr., ♂♀, freq.; (19) A. rugosa Rob., ♂♀, ab.; (20) A. mariæ Rob., ♂, freq.; (21) A. claytoniæ Rob., ♂♀, ab.; (22) A. förbesii Rob., ♀; (23) Colletes inæqualis Say, ♂, freq.; *Ichneumonidæ*: (24) Lampronota coxalis Ashm. (MS.), ♀, type.

DIPTERA — *Empidæ*: (25) Rhamphomyia priapulus Lw.; *Syrphidæ*: (26) Syrphus americanus Wd., freq.; (27) S. ribesii L.; (28) Eristalis dimidiatus Wd.; *Tachinidæ*: (29) Gonia frontosa Say, freq.; *Sarphagidæ*: (30) Cynomyia mortuorum L.; *Muscidæ*: (31) Lucilia cornicina F., freq.; *Sciamyzidæ*: (32) Tetanocera pictipes Lw.; *Lonchæidæ*: (33) Lonchæa polita Say — all sucking.

On the literature of *Rhus* see:

(1) Hildebrand, Geschlechtsvertheilung bei den Pflanzen 10. 1867 — *R. Toxicodendron.* (2) Axell, Om anordningarna für de fanerogama växternas befruktning 47. 1869 — *R. Toxicodendron.* (3) Delpino, Altri apparecchi dicogamici recentemente osservati, Nuovo Giorn. Bot. Ital. 2:52. 1870. (4) Müller, Befruchtung der Blumen 157–8. 1873. (5) Delpino, Ulteriori osservazioni, Part II, fasc. 2:20, 214, 300. 1875, Atti. Soc. Ital. Sci., Milano 16: 168. 1873; 17. 1874 (Just. 2: 882, 895). (6) Meehan, On hermaphroditism in *Rhus cotinus* and in *Rhus glabra*, Proc. A. A. A. S., 1873; B. 73–5. (7) Meehan, On self-fertilization and cross-fertilization in flowers, The Penn Monthly, N.1876 (Just. 4:939). (8) Müller, Das Variiren der Grösse gefärbter Blüthenhüllen und sein Einfluss anf die Naturzüchtung der Blumen, Kosmos 2: 132–3. 1887 — *R. Cotinus, typhina* (Just. 5: 740–1). (9) Bonnier, Les Nectaires, Ann. Sci. Nat. Bot. VI, 8: 71. 1878 — *R. Cotinus.* (10) Patton, Observations on the genus Macropis, Am. Journ. Sci. and Arts III, 18: 211, 212. 1879 — *R. glabra typhinæ* (Just 7[1]: 145). (11) Bontroux, Sur l'habitat et la conservation des lévures spontanées, Bull. Soc. Linn. Normandie, III, 6. 1881 — *R. Cotinus* (Just 13[1]: 745). (12) Müller, Die biologische Bedeutung der Blumenfarben, Biol. Cent. 3: 99. 1883 (Just 9[1]: 506). (13) Müller, Die Stellung der Honigbiene in der Blumenwelt, III, Bienenzeit, Jahrg. 39: 157–161. 1883 — *R. typhina* (Just 11[1]: 476). (14) Müller, Fertilization of Flowers, 166–7. 1883. (15) Schulz, Beiträge Zur Kenntniss der Bestäubungseinrichtungen and Geschlechtsvertheilung bei den Pflanzen 2: 62–4, 186. 1890, Bibliotheca Botanica 17 (Just 18[1]: 517). (16) Kerner, Pflanzenleben 2: 192, 297. 1891; Kerner & Oliver 2: 173, 197, 297. 1895 (Just 17[1]: 531, 2; 18[1]: 486). (17) Engler, Anacardiaceæ, Engler u. Prantl, Die nat. Pflanzenfamilien, 73: 142. 1892 [Th. III, Abth. S] — *R. Cotinus* (Just 20[1]: 481). (18)

Meehan, Contributions to the life histories of plants, VIII, Proc. Acad. Nat. Sci., Phila., 1892, 369–71 (Just 20[1]: 494). (19) Robertson, Flowers and insects, XII, Bot. Gaz. 19: 111, 112. 1894. (20) Loew, Blütenbiologische Floristik, 215 — *R. Cotinus.*

SASSAFRAS OFFICINALE Nees. *S. Sassafras* (L.) Karst. Hildebrand (1) observes that the pistillate and staminate flowers each have rudiments of the other set of organs, being what Kerner (2) calls pseudo-hermaphrodite. According to Bentham and Hooker's Genera Plantarum, and Gray's Manual this species is dioecious; and that is what I have always regarded it, though I paid attention to little except the insect visitors. Chapman, in the Flora of the Southern States, calls it diœciously polygamous, while Kerner calls it polygamous. My observations were made upon trees which I supposed bore only staminate flowers.

The flowers are greenish yellow, expand about 8 or 9[mm], and are arranged in corymbose clusters, which appear with the leaves. There are nine stamens. The three inner ones have at base of each a pair of stalked glands which secrete nectar. The nectar is therefore fully exposed on a convex surface.

There are a number of early flowers with convenient nectar, some of which on account of their greenish yellow color have been supposed to be principally visited by flies. In all except *Caulophyllum* and *Sassafras* the less specialized bees, Andrenidæ, outnumber the flies. *Sassafras* is the only one on which the flies clearly preponderate. In most of the species the nectar tends to collect in shallow cups, which make it very convenient for the Andrenidae, while in *Caulophyllum* and *Sassafras* it is secreted on convex surfaces, which make it more convenient for flies and less convenient for the little bees. However, the exposure of the nectar does not explain why *Sassafras* shows a preponderance of Diptera, but only why it shows more flies than the other greenish yellow flowers blooming about the same time. During the blooming season, April 19th–May 7th, the flowers are exposed to none of the lower aculeate Hymenoptera, except eight species of *Vespa* and *Polistes* and *Priocnemis conicus*. The last is the only one of these taken on the flowers. It happens to be the only one of the *Pompilidæ* flying during the blooming season. Sup-

pose that *Sassafras* bloomed in the last of July, what would there be to keep it from being visited by several of the nineteen species of *Pompilidæ* flying at that time, or by many other short-tongued Aculeata which are then very abundant? In the south the lower Aculeata begin to fly earlier, and I should expect *Sassafras*, and many other early flowers with exposed or slightly concealed nectar, to show an increase in the proportion of these insects as we move in that direction.

The following insects were taken on the flowers on April 27th and 29th:

HYMENOPTERA—*Andrenidæ*: (1) Halictus cressonii Rob., ♀; (2) H. confusus Sm., ♀, s. & c. p.; (3) H. stultus Cr., ♀; (4) Andrena sp. ♀; (5) A. illinoensis Rob., ♂; (6) A. hippotes Rob., ♂; *Pompilidæ*; (7) Priocnemis conicus Say; *Chalcididæ*: (8) Eurytoma sp.; *Ichneumonidæ*: (9) Pimpla annulipes Br.; (10) Idiolespa anilis Grav.; (11) Ophion bifoveolatum Br.; *Tenthredinidæ*: (12) Hylotoma mcleayi Leach; (13) Monophadnus medius Norton.

DIPTERA—*Simulidæ*: (14) Simulium pecuarum Riley; *Bibionidæ*: (15) Bibio pallipes Say, freq.; (16) B. femorata Wd.; *Stratiomyidæ*: (17) Sargus iridis Say; *Empidæ*: (18) Empis compta Coq. (MS); (19) Rhamphomyia ravida Coq. (MS); (20) R. piligeronis Coq. (MS.); (21) R. priapulus Lw., freq.; (22) R. mutapilis Lw., freq.; (23) R. exigua Lw.; *Syrphidæ*: (24) Chilosia versipellis Will., freq.; (25) Chrysogaster nitida Wd.; (26) Platycheirus hyperboreus Staeg.; (27) Syrphus americanus Wd.; *Tachinidæ*: (28) Nemoræa aldrichii Twns.; (29) Gonia frontosa Say; (30) Micropalpus fulgens Mg.; (31) Phorocera edwardsii Will.; *Sarcophagidæ*: (32) Cynomyia mortuorum L., freq.; (33) Sarcophaga sp.; (34) S. cimbicis Twns.; *Muscidæ*: (35) Lucilia sp.; (36) L. cæsar L.; (37) L. cornicina F.; (38) Morellia micans Mcq., freq.; *Anthomyidæ*: (39) Homalomyia prostrata Rossi; (40) Caricea antica Wlk.; (41) Phorbia acris Wlk., ab.; (42) P. fusciceps Zett., ab.; *Cordyluridæ*: (43) Scatophaga squalida Mg.; *Oscinidæ*: (44) Chlorops trivialis Lw.; *Agromyzidæ*: (45) Agromyza latipes Mg.; (46) A. æneiventris Fll.

COLEOPTERA—*Lampyridæ*: (47) Telephorus bilineatus Say, freq.; *Œdemeridæ*: (48) Asclera puncticollis Say.

HEMIPTERA—*Corimelænidæ*: (49) Corimelæna pulicaria Ger.—all only sucking, except No. 2.

On the literature of *Sassafras* see:

(1) Hildebrand, Geschlechtsverteilung bei den Pflanzen 9. 1867. *Laurus Sassafras*: (2) Kerner, Pflanzenleben 2:297. 1891. Oliver, translation, 288 1895—*L. Sassafras*.

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